ON A FEW CALIFORNIAN MEDUSÆ.

BY J. WALTER FEWKES.

VERY little is known of the different genera and species of Medusæ which live in the waters contiguous to the coast of Southern California. There is every reason to believe that this fauna is very rich, and extremely interesting and instructive so far as its geographical distribution is concerned. The animals of this group from the west coast are represented by genera and species widely different from those found on the Atlantic seaboard. The coast of California, washed as it is by the largest ocean of the globe, is bathed by great oceanic currents, bringing with them their quota of oceanic and pelagic life. We should naturally expect there forms of medusan life of strange appearance to one who has always studied similar animals from the Atlantic.

A few attempts have been made to use the dip-net in the Pacific coast, but we cannot say that more than a beginning has been made, and it may rightly be concluded that an abundant harvest awaits the collector of pelagic animals who first carries on continued work in these waters.

In the present paper I have attempted to consider a few representatives of the group of Medusæ which were captured in a trip across Santa Barbara Channel in the spring of 1887. No accounts[1] of several of these Medusæ have ever been published, although some of them are very different from those which are found in the waters of the Atlantic. Our work on these animals may serve as an introduction, or to call attention, to a line of

[1] I refer simply to the floating medusan life, not to the fixed hydroids. There are several elaborate papers on the Hydroidea of the coast of California, which give a very good idea of the general facies of this group from this locality. This paper deals only with the floating Medusæ, and only makes casual mention of one or wo fixed hydroids, of which little or nothing is known.

investigation which is destined to reveal a rich harvest to any one who may take up the study of these facinating animals. There is no subject which would more richly repay observation than that of the Medusæ of California. I have here pointed out the most important general structural features of these genera, and have introduced a few comparisons with similar genera from the Atlantic, with which students of zoölogy are more familiar.

Of the group called Acraspeda, or Discophorous Medusæ, a species of Pelagia is one of the largest and most striking of those which make their way into the Santa Barbara Channel. Compared with the Pelagia of the Atlantic and Mediterranean Sea, *Pelagia noctiluca*, the Pacific Ocean representative, *P. panopyra*, is a veritable giant. Specimens were captured which had the "tentacles" of the mouth over four feet in length, and the dimensions of the body in proportion. The Atlantic Ocean Pelagia is commonly not more than a fifth of the size of this form.

The first figure gives a representation of the general form of this Pelagia as it was observed floating near the surface of the water in mid-channel. The umbrella, which forms the upper portion or body, is over two feet in diameter, and from the center of the under side there hang down four long, frilled, flexible tentacles, which form the lips of the mouth, or oral aperture. There are eight "sense-bodies" arranged at regular intervals around the margin of the umbrella, alternately with which arise the tentacles, or the long, thread-like structures conspicuously shown in the figure. This Medusa, from its very large size, is one of the most striking, and seems to be common at certain seasons of the year, according to reports given to me by the fishermen, but I was able to collect only a half dozen good specimens. The examples captured had a beautiful pink color, which was especially brilliant on the tentacles and exterior of the umbrella.

The genus of Acraspeda called Aurelia, represented on the Atlantic coast by the well-known *A. flavidula*, is also found in the Pacific, and is represented on the coast of California

by a beautiful species, *Aurelia labiata*. This species, like the Atlantic, has eight sense-bodies on the bell-margin, between which there are numerous short tentacles as represented in Fig. 2. The color is more pinkish than that of *flavidula*, but the specimens observed are smaller. It was met with but once in my surface fishing in the Santa Barbara Channel, but north of Santa Barbara, at Monterey, it was found several times, and according to trustworthy reports this jelly-fish is very common, in certain months of the year, along the west coast of the United States.

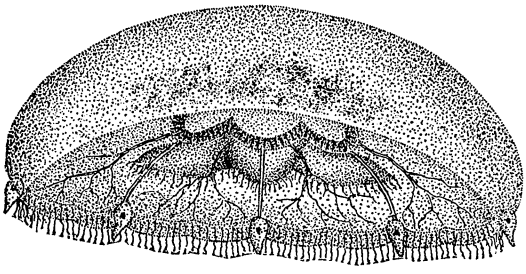

FIG. 2.—*Aurelia labiata.*

One of the most beautiful, conspicuous and abundant jelly-fishes found in the Santa Barbara Channel in the Spring months is a genus Polyorchis, represented by a single species, *Polyorchis penicillata* (A. Ag.) This Medusa is common in all stages of growth, and often swarms in the waters about the landing places. It is easily recognized by the peculiar character of the radial chymiferous tubes, which are four in number, and from their sides there arise lateral branches as shown in the figure. The ovaries hang from the upper portion of the manubrium from a gelatinous elevation or extension of the bell which bears the proboscis. This position of these organs is peculiar, for while Polyorchis belongs to the so-called Tubularian hydroids, in none of which these otocysts are situated on the bell margin, the position of the sexual bodies is exceptional. In the majority of the Tubularian or Anthomedusan hydroids the sexual bodies arise from the proboscis itself, but here these bodies hang from a gelatinous extension of the bell, or, more exactly, form the radial tubes which cross this prominence. Practically, therefore, we have here a Medusa which has characters of hydroids like Sarsia and those like Oceania, representatives of two groups, for while

otocysts are wanting on the bell margin, as in Anthomedusæ, the sexual bodies hang from the radial tubes on the bell as in Leptomedusæ or Oceania-like genera. In most respects, save the simple position of the sexual bodies, Polyorchis is however a true Tubularian.

The youngest form of Polyorchis which was found betrays clearly the affinities of the adult, since it shows that the side branches from the radial tubes are in reality structures of comparatively later growth in the development of the Medusa. The accompanying figure represents an undeveloped or young individual of Polyorchis before the side branches of the tubes had formed, and before the tentacles had reached any considerable length. Like the younger forms of many young Medusæ of widely different genera we find clusters of small bodies superficially resembling nematocysts strewn over the external surface of the bell. The immature Medusa has no apical prominence on its bell, and in general its umbrella is more elongated, with a longer vertical diameter, than the adult. All stages of growth between the young represented in Fig. 4 and the adult can be easily collected.

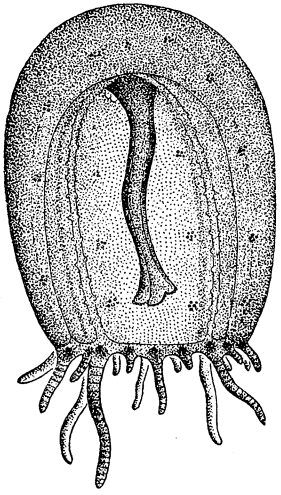

FIG. 4.
YOUNG POLYORCHIS.

There is another very curious Medusa likewise belonging to the Anthomedusæ, which is found in the vicinity of the Island of Santa Cruz.[1] This Medusa is so remarkable that a figure of it is introduced for comparison with related representatives from the Atlantic coast.

One of the most interesting genera of Tubularian Medusæ

[1] The island of Santa Cruz is the nearest of the Santa Barbara islands to the city of the same name.

PLATE XXIII.

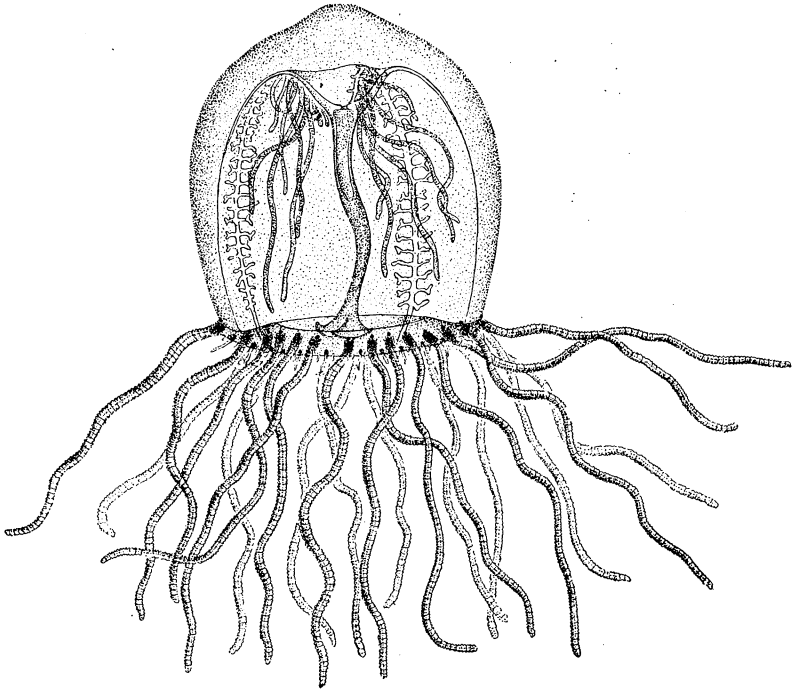

FIG. 3.—*Polyorchis penicillata.*

found in the waters of the Atlantic is a strange genus called Dipurena. This jelly-fish is remarkable from the fact that while its bell resembles closely that of Sarsia, the Medusa of Syncoryne, the form of the tentacles is very different. While Sarsia has long, highly-flexible tentacles, Dipurena has, in the same position, arranged at regular intervals on the bell, nine stiff club-shaped appendages, enlarged at their tips into clavate organs of unknown function.[1] The form of the bell, the structure of the tentacles and the proboscis of Dipurena have been figured in my paper on the "Jelly-fishes of Narragansett Bay," to which the reader is referred for a knowledge of the peculiarities of this most interesting animal. The points with which we have at present to deal are the following: Dipurena has a hemispherical bell, four simple radial chymiferous tubes, and four stiff tentacles which are enlarged at their extremities into club-shaped bodies resembling small dumb-bells. The length of the proboscis is very much longer than the height of the bell cavity, and through its walls the ova can sometimes be seen in packets occupying two regions. The mouth is simple, resembling that of Sarsia, and at the base of the stiff tentacles on the bell margin there are simple pigment spots or ocelli. Dipurena is rare on the coast of New England, but it seems to be more common in the Gulf Stream, and occurs in numbers in Floridan waters and on the Carolina coast.

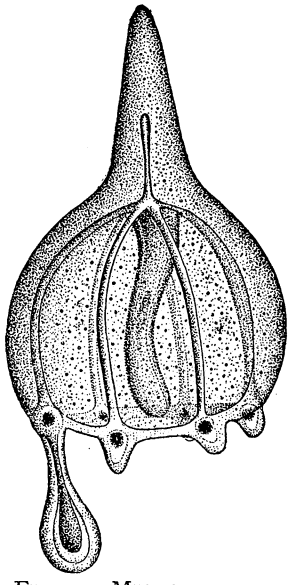

FIG. 5.—MICROCAMPANA.

Under the lofty cliffs of the island of Santa Cruz, opposite Santa Barbara, a Medusa with certain of the characters of Dipurena was taken in the Spring of 1887. There are features of this Medusa which stamp it as a most characteristic one, and

[1] It seems highly improbable that the function of these clavate appendages is the same as that of the long flexible appendages or tentacles of Sarsia.

as highly exceptional, differing from any which has yet been described. I suggest for it the name Microcampana, the structure of which is indicated below. Microcampana has *six* radial chymiferous tubes instead of four, eight or a larger number, as ordinarily occurs among its nearest allies.

Among Hydromedusæ the majority of genera have four radial tubes, but there are several, as Melicertum, which have eight, and still others, Zygodactyla, which have more than eight. Four, however, is the normal number in the majority of genera, and there are only two or three which have six. Microcampana is therefore in the first place exceptional in the number of radial tubes. It has, moreover, a single club-shaped tentacle, resembling, it is true, that of Steenstrupia in the fact that it is single, but closely allied to those of Dipurena in anatomical characters. It is the only known genus which approaches Dipurena in the peculiar form of the tentacles. Unlike the last-mentioned genus, the apex of the bell is prolonged into a conical projection, through the middle of which, at least in its basal region, passes a small tube, the homologue of which is found in several genera where it is often the remnant of a former connection with the hydroid from which the Medusa has been formed by gemmation. The conical projection at the apex of the bell is exactly reproduced in two Atlantic genera, Stomatoca and Dinematella, neither of which, however, has less than two tentacles. To recapitulate, then, we have these extraordinary features in Microcampana, which are found in combination in none of the known Hydromedusæ which have yet been described: there are *six radial chymiferous tubes, a single tentacle, which is inflexible, and enlarged at its tip into a dumb-bell-shaped structure*, and an apical projection on the bell penetrated by a median canal originating from the common junction of the four radial tubes, and terminating blindly in the substance of the projection.

It is probable that the size of this Medusa (it is barely an eighth of an inch in diameter), and the existence of but a single tentacle, are indications of immaturity. It may later be found that other tentacles are developed, and new affinities be sought for it. To this conclusion, the fact that a remnant of what may be a former

PLATE XXIV.

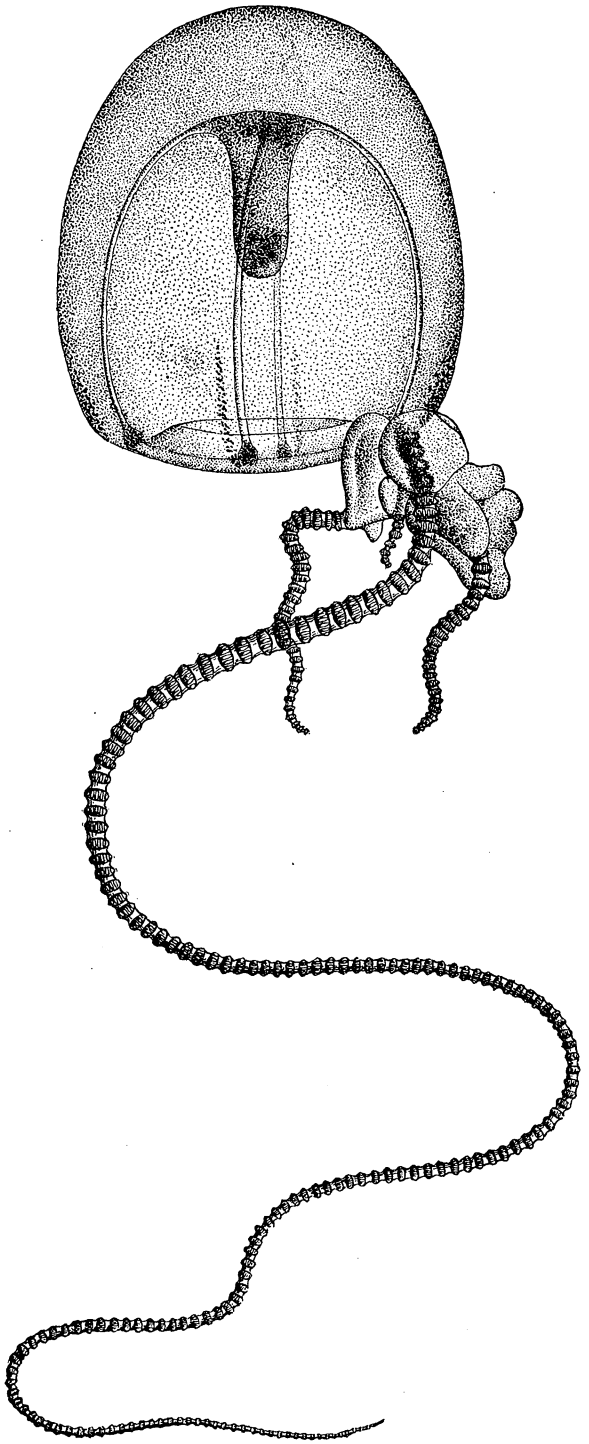

FIG. 6.—*Steenstrupia californica.*

connection with the hydroid, seen in the apical projection, adds some weight. Even if it is an immature Medusa, the character of the tentacles, so like those of Dipurena, is exceptional. The specimen cannot be confounded with Dipurena on account of the greater number of radial tubes.

It may be urged with some weight that we are dealing with an abnormal specimen, and that the extra tube is an abnormality. Granting that such is the case, the apical projection remains as a feature not possessed by any of the species of Dipurena, and ordinarily the apical projection is a late formation on the bell of a Medusa as shown in the development of Stomatoca and Dinematella.

Microcampana is not the only unitentacular Medusa found in the prolific waters of our Pacific coast. A second genus, known from the Atlantic for many years, is also represented in the Santa Barbara Channel.

A bizarre genus of Hydromedusæ, found on the Atlantic coast, is known as Hybocodon, the "hunchback" Medusa. The same, or a very similar, genus from Europe is called Steenstrupia. There genera are remarkable from the fact that they have but one long, flexible tentacle. One of the most interesting features of this Medusa is that the young arise as buds from near the attachment of this tentacle to the bell margin. It is a true Tubularian, with the peculiarities of that group, but has three of the tentacles so reduced as to be wholly wanting, while the fourth is very much prolonged and is highly flexible, armed with ferules of powerful "stinging cells,"—nematocysts. The young, with the bells in process of formation, each with its own tentacle more or less completely developed, and clustered at the base of the long tentacle of the parent, can be seen in my figure. When sufficiently developed these budding individuals probably break their connection with the mother, and from the bases of their tentacles in turn they develop new broods.

Among the many other Hydromedusæ which live in the Californian waters, one of the most beautiful is closely allied to Sarsia, a genus abundant at times in Massachusetts Bay. This beautiful animal has received the name *Sarsia rosaria*, and is the

free gonophore of a form of hydroid called Syncoryne. The simple structure of this Sarsia can be seen in the two cuts, the smaller of which represents the young, the larger the adult form of the same jelly-fish. They were found very abundant near Monterey and Santa Cruz, and several specimens were taken from the Santa Barbara Channel, where, however, they were not found as abundantly as in the former locality. The species is readily distinguished from the Atlantic representative by its greater size and by the color, while the proboscis is much shorter than that of *Sarsia mirabilis*, so abundant at times on the coast of New England.[1] As is well known, the Anthomedusan and Leptomedusan groups of Hydromedusæ are supposed to arise as buds from fixed hydroids, excepting perhaps the somewhat doubtful case of the Lizzia recorded from Scotland, of Claparede. In genera where we have young Medusæ budding from Medusæ among these groups, as in Lizzia, Sarsia, and others, it is not impossible that a direct development in which no fixed stage is found, direct development not unlike that of Cunina, may exist, but such a form of development has yet to be described. The genus Sarsia has a development of young by the budding of new individuals from the proboscis of the parent *S. prolifera*, and from a fixed hydroid Syncoryne.

The piles of the wharf at Santa Barbara are peopled by a beautiful pale pink hydroid, belonging to the genus Syncoryne, which may possibly be the hydroid of the Sarsia just described. These hydroids are found in clusters with a common basal connection, each head rising from a single stem as shown in the figure given here. On a single magnified head we detect the club-shaped tentacles and the ovate "buds," which are Medusæ in all stages of

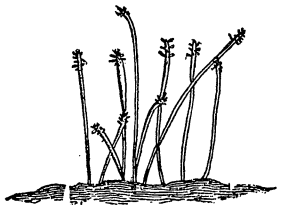

FIG. 8.—CLUSTER OF SYNCORYNE HYDROIDS.

[1] The hydroid Acaulis, found at Grand Manan and Eastport, Maine, is a most interesting genus of free hydroids with Medusa buds. This genus, which might be mistaken for the head of a Monocaulis, is probably an interesting connecting link between the Siphonophora and the fixed hydroid or its homologue the budding Cunina.

PLATE XXV.

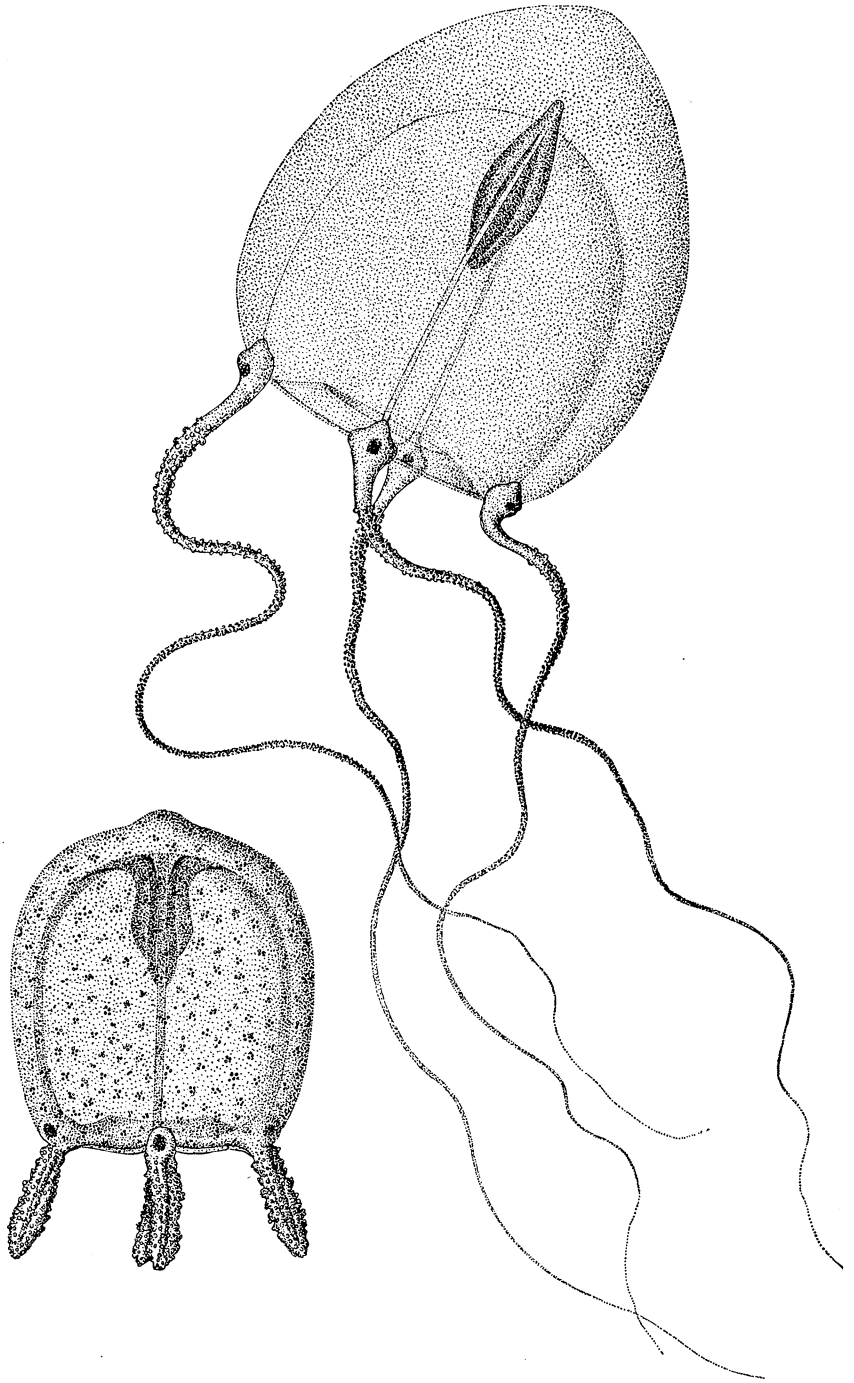

FIG 7.—ADULT AND YOUNG OF (*Sarsia*) *Syncoryne rosaria.*

development. I have not been able to trace these "buds" into

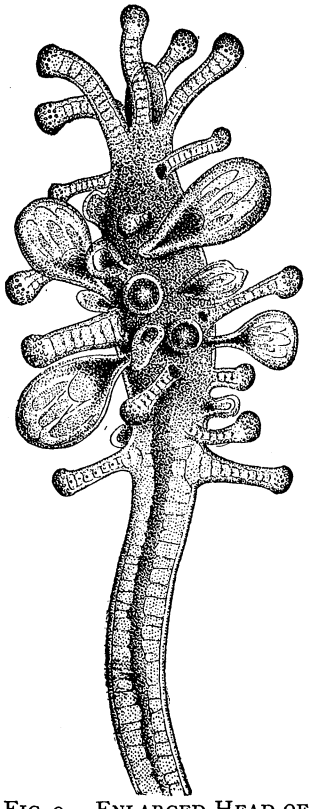

FIG. 9.—ENLARGED HEAD OF A SINGLE SYNCORYNE.

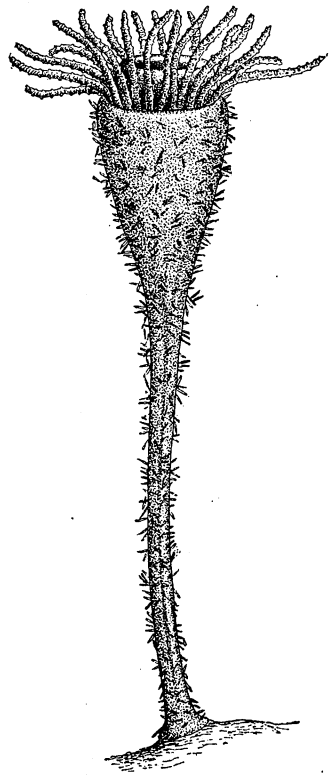

FIG. 10*a*.

a young Sarsia, but from what is known of the hydroid of the Atlantic Sarsia, it seems highly probable that this hydroid is the young of the Pacific Coast Sarsia.

Associated with the preceding hydroid on the piles of the wharf at Santa Barbara, there is another hydroid not yet determined, figures of which are given herewith. These hydroids belong to the second group of Hydroidea, or the Campanularians, and are found in clusters, as shown in the first figure. The larger cut represents a single head, very much magnified, with the tentacles

FIG. 10.

partially retracted. Along the sides of the body clusters of unicellular algæ are seen, which sometimes occur in such numbers as to almost completely conceal the body of the hydroid.

There is another curious Hydromedusa, which was taken in the skimming nets used in pelagic fishing in the Santa Barbara Channel. The genus Willia is remarkable for the bifurcation of the radial chymiferous tubes, as shown in the cut.

This interesting genus, never before recorded from the waters of California, is related to the young of a genus Proboscidactyla, and the Medusa figured may belong to this genus.

One of the most interesting Medusæ from the Santa Barbara Channel is a little-known genus, Athorybia. Athorybia is a member of the group of Siphonophora known as the Physophoræ, although it bears little superficial likeness to Agalma and Physalia, two of the best-known members of the group.

The anatomy of Athorybia is simple. The most prominent structure is an oval float of pink color, from which there hangs a tube-like or trumpet-shaped body, as represented in my figure. At the base of the float there arises a circle of leaf-like bodies, transparent, gelatinous, penetrated from end to end by a tube, and crossed in their exterior by motor lines of lasso-cells. Very flexible bright pink bodies called tasters hang out from beneath the flat leaves, or, as they are called, the covering-scales, and long, highly flexible tentacles extend far beyond the tips of these and other organs of the body. Each tentacle bears a tentacular knot, as it is called, which are lateral branches, enlarged at one end, and with the termination divided into three divisions. The main body of the knob at the end of the lateral branches is composed of a spirally-coiled structure, covered by batteries of stinging cells, and partially enclosed in a covering-sac or involucrum, which is extended on one side into a conical projection or apex, as represented on the figure. There is but one kind of these structures along the tentacles of Athorybia, but in the neighboring genus Diplorybia from Florida there are two kinds of these structures.

The interpretation of the function of the organs of Athorybia described above, is in certain respects not difficult. The large

PLATE XXVI.

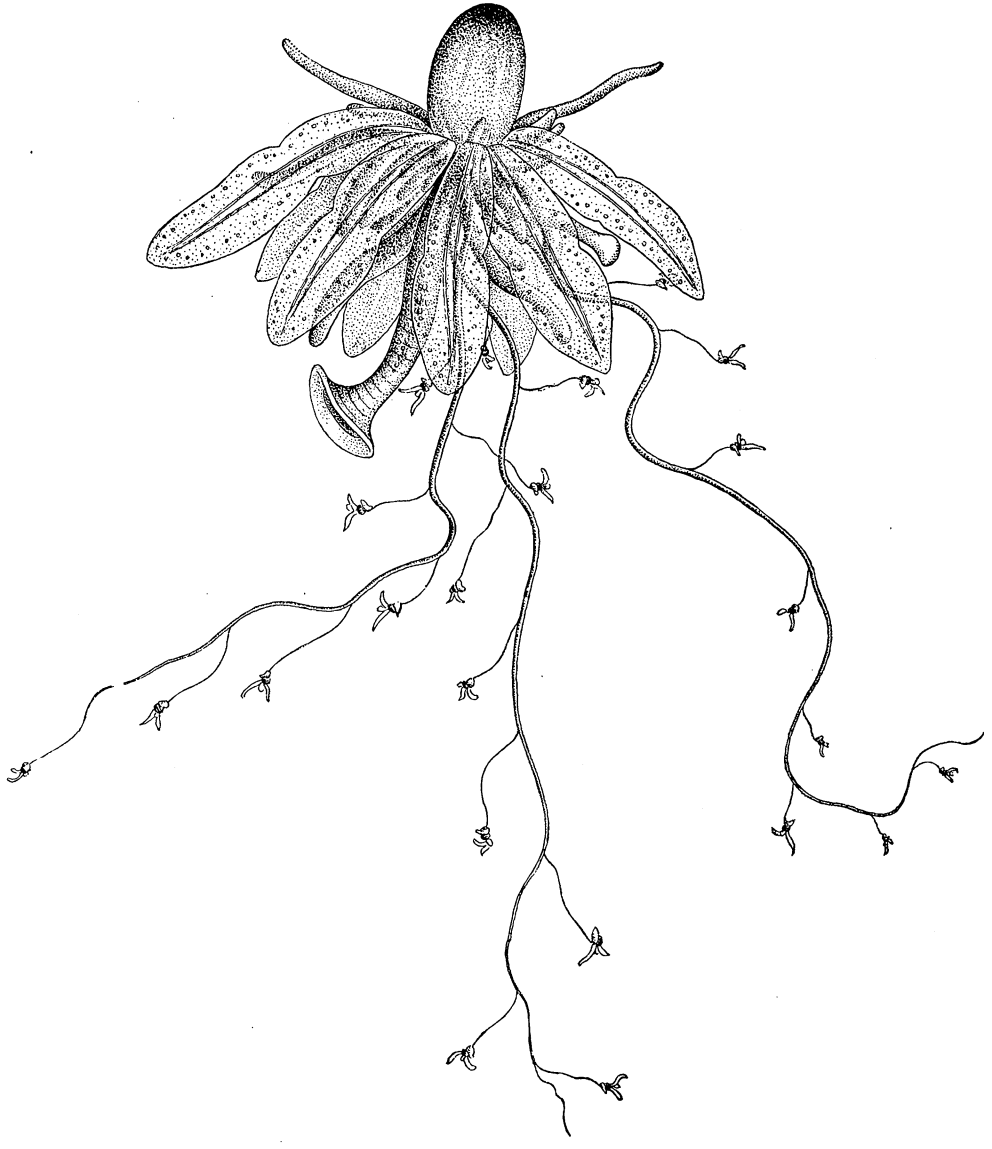

FIG. 12.—*Athorybia californica.*

oval body above is a float, the flask-shaped or trumpet-like organ the polypite, whose inner wall serves as a digestive organ, and whose terminal opening is a mouth for the capture of food. The leaf-like covering-scales, sheltering beneath themselves the other organs or zoöids, often keep up a flapping movement, by means of which the Athorybia is propelled from place to place. The function of the tentacles and tentacular knobs is probably the capture and retention of the prey. No sexual bodies were observed, from which we may readily conclude that the specimens which were captured were immature.

One of the most interesting of all the surface animals of the ocean is a beautiful genus called Velella, which receives its name from its fancied resemblance to a "little sail-boat." This genus is often so common in the Mediterranean Sea that the surface of the water appears to be almost covered with them, and after favorable winds they are sometimes accumulated in great masses along the shores and in the small bays and harbors of the Italian coast. In Florida, likewise, a similar animal occurs in great numbers, and stragglers often make their way even to the New England coast, where they are often stranded on our Southern beaches.

A Californian species of Velella, found along the west coast of the United States, occurs in the waters of the Santa Barbara Channel, and although often very abundant, is at times rather rare. Its bright blue color and its strange form make it a noteworthy Medusa.

In the accompanying cut there is shown a view of this Californian Velella, as seen from above, looking down upon it as it floats on the surface of the sea. The diagonal oval region, crossed by a thin triangular plate, the edges of which are seen in the figure, is the float, which is composed of many concentric apartments, each opening exteriorly by a small orifice, and all communicating with each other. The larger oval is the body of the Medusa, and as it floats on the surface of the water this portion, which is flat, forms the great mass of the animal. Through its walls, which are of bluish color, the tentacles can be seen,

but the feeding-polyp, which lies in the centre of the under-side, is hidden by the oval float in the middle of the body.

Of all the Medusæ considered, Velella is the only one which floats on the surface of the sea, the whole upper surface of the body, or that shown in the figure, being exposed to the air. From this fact, as well as from certain rhythmical motions made by Velella, it is not improbable that the respiration is in part aerial in this Medusa, as has been already pointed out by Dr. Carl Chun. To facilitate this mode of respiration, and to bring the air into the interior of the body, there are tubes, called tracheæ, communicating with the cavity of the float, through which air is taken in and gas expelled by the movements of the body. At the same time there is also an abundant opportunity for aerial respiration through those parts of the body which are always exposed to the air.

NOTES ON THE HABITS OF SOME AMBLYSTOMAS.

BY O. P. HAY.

MY observations on the habits of the Amblystomas have been made almost wholly on the three species, *A. microstomum, A. tigrinum, and A. punctatum.* These species have received respectively the vernacular names, small-mouthed salamander, tiger salamander, and spotted salamander. All three are quite abundant about Indianapolis, the *microstomum* most of all; and it is this that I have been enabled to study most carefully. Unless otherwise noted, my remarks will refer to this species. It will be most convenient perhaps to begin with the life of the individual; first of all with those events which make provision for the life of the individual.

The eggs of the small-mouthed salamander are laid very early in the spring, as soon as the thick ice of the winter is gone, or even before it is gone. During the present year I found eggs of this species at noon of March 3. They had probably been laid during the preceding night. They were attached singly